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# FAO Plant Protection Bulletin

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World Reporting Service on Plant Diseases and Pests

## Present Status of the Tristeza Disease of Citrus in South America

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**I**N less than two decades, the onslaught of the tristeza disease in South America practically destroyed most commercial orchards established on the sour orange (*Citrus aurantium*) rootstock in parts of Argentina and Brazil. In the State of São Paulo, Brazil, this disease killed upwards of 7,000,000 trees (29). In Argentina, the number of trees killed by the disease was equally high (40). Tristeza is now present in other South American countries (3, 7, 38) and it is one of the major factors to be considered by the citrus industry of that continent.

### Present Economic Importance

Very few plant diseases have caused such devastating losses as those that resulted from the ravages of tristeza in the citrus orchards of Argentina and Brazil. Now, however, the use of tristeza-tolerant rootstocks is permitting the citrus industry in these countries to recover. São Paulo has planted over 4,000,000<sup>1</sup> trees on tristeza-tolerant rootstocks.

The tristeza virus is present today in most commercial citrus groves of Argentina, Brazil and Uruguay with trees budded on tolerant rootstocks. Non-infested orchards in these countries and other South American areas where the disease has not yet been reported are certain to become invaded sooner or later. Once an area becomes

infested by the disease, it is impossible to eradicate it because of the wide distribution of the tropical citrus aphid, *Aphis citricidus* Kirk, which is a highly efficient vector (8, 25) and because of the presence of certain seedling types of citrus as well as trees of tristeza-tolerant combinations which are symptomless carriers of the virus (2, 14).

In greenhouses, infected plants of tolerant combinations are slightly stunted in comparison with non-inoculated controls. Under field conditions in São Paulo it is not possible to compare the performance of healthy and diseased plants of tolerant combinations as healthy greenhouse plants become infected soon after they are set in the field. Although trees of tolerant combinations bear satisfactorily, the presence of the virus may be detrimental to the plant and consequently to the yield. It is also possible that tristeza-infected, tolerant combinations may have a shorter productive life than if non-affected.

### Introduction and Spread of Tristeza

It is generally accepted that tristeza was introduced into South America from Africa, where the disease has been recognized for over 50 years. Citrus shipments from South Africa to Argentina have been traced as far back as 1929 (40) and 1930,<sup>2</sup> but it is possible that earlier shipments had been made (13). The disease may have been

<sup>1</sup> Information received from S. Moreira, Head, Section of Citriculture, Instituto Agronômico de Campinas, Brazil.

<sup>2</sup> Information kindly supplied by Dr. P. C. J. Oberholzer, Horticulturist, University of Pretoria, South Africa.

introduced into Brazil from Argentina, where it seems to have appeared earlier. It was also possibly introduced directly from Africa in living plants or budwood by large concerns owning citrus orchards in both South Africa and in Brazil.

The organization of large collections of citrus with the introduction of nursery trees or budwood material is probably one of the factors in the distribution of tristeza, as well as of other virus diseases, to uninvaded areas. It has been verified that certain standard varieties of citrus are carriers of the tristeza virus (32, 33). Thus, the introduction of living material of these, or of other varieties that may carry the virus, even from areas supposedly free from tristeza, involves considerable risk. It might happen that in some areas tristeza is not known to occur, simply because the disease has not been destructive, or may not have spread for lack of an efficient insect vector.

### **Detection of Tristeza**

In citrus-growing areas considered free from tristeza, it becomes important to enforce strict quarantine measures to prevent the introduction of the disease. It is also important to ensure that the disease has not already been introduced into the area, but has escaped attention, due to little or no spread, or because tristeza-tolerant combinations are commonly used.

The association of stem-pitting with symptoms of tristeza in certain host plants (10, 23, 41) provides a useful method of detecting tristeza in areas where grapefruit or West Indian limes might be found in some orchards. It was the observation of stem-pitting symptoms that permitted the discovery and identification of the tristeza disease in Hawaii (16).

The fact that certain varieties of West Indian limes (9) or other citrus types may be used as a seedling test plant for tristeza is useful for greenhouse or nursery testing of buds for the presence of the virus. The histological study of the phloem at the bud-union of trees showing indications of decline is also of great help in the identification of tristeza (35, 36). Detailed discussions of methods of identification have been given elsewhere (17, 30).

### **Control of Tristeza before Determination of its Nature**

To the chagrin of pathologists, the discovery of practical control methods for tristeza anteceded the determination of the virus nature of the disease. In Argentina (4) and in Brazil (26), where a variety of rootstocks had been used in commercial citrus orchards, it became evident soon after the spread of tristeza that trees on rootstocks of sweet orange (*Citrus sinensis*), Rangpur lime (*C. aurantifolia*, or possibly *C. reticulata* x *C. aurantifolia*), tangerine (*C. reticulata*), Rough lemon (*C. limon*) and the trifoliata orange (*Poncirus trifoliata*) were not visibly affected by the disease, whereas neighboring trees or orchards on sour orange rootstock were wiped out.

When tristeza reached the area around Limeira, in the State of São Paulo, it spread to the well planned rootstock experiments of the Citrus Experiment Station of the Instituto Agronômico de Campinas. Experimental data (27) confirmed previous field observations that tristeza was a disease affecting principally those combinations in which the sour or bitter oranges were the rootstock. It also confirmed that sweet orange, Rangpur lime, Rough lemon, tangerina cravo, and the trifoliata orange were tristeza-tolerant rootstocks.

### **Reaction of Citrus Types**

Two characteristics are mainly concerned in the reaction of citrus types to infection by tristeza: *a*) the ability of the plant to permit virus increase, and *b*) the tolerance of its tissues to the presence of the virus. Thus, basically, seedling citrus types may belong to one of four classes: 1) susceptible to infection with tolerant tissues, e. g., sweet orange, mandarins, and some tangelos; 2) susceptible to infection with intolerant tissues, e. g., West Indian limes and certain grapefruits; 3) highly resistant or immune with tolerant tissues, e. g., the trifoliata orange and some of its hybrids; and 4) resistant or immune with intolerant tissues, e. g., *Severinia buxifolia*.

Visible effects of the disease appear mostly in representatives of class 2, in which injury is caused by the increase of the virus to

## REACTION OF CITRUS TYPES TO TRISTEZA

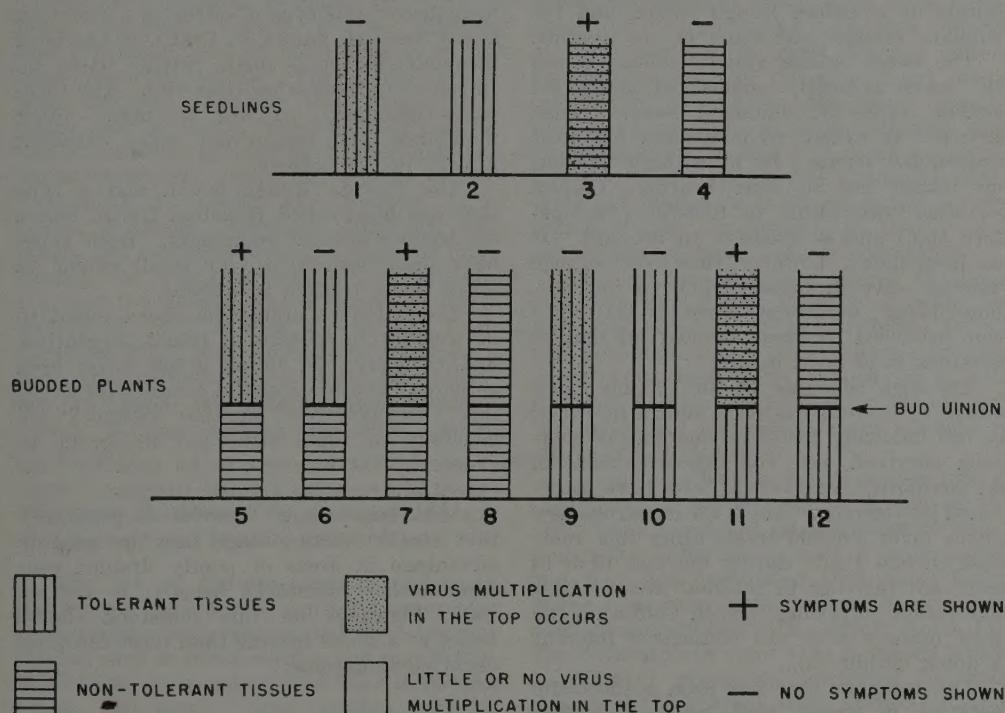


Figure 1. Schematic representation of the reaction of seedling and budded citrus types to tristeza.

critical concentrations in non-tolerant tissues. Seedlings of this group which show symptoms can be used as test plants in studies of the disease (9).

The reaction of a budded plant to tristeza results from an interaction between characteristics of the scion and those of the rootstock. In the rootstock, however, the tolerance or intolerance of its tissues is what counts most, since virus multiplication takes place mostly in the top. As previously stated (2), injury from tristeza will always occur in a budded combination when a length of highly intolerant tissues exists between a top that permits virus increase and the roots of the plant. The interpreta-

tion of tristeza injury on these bases explains the results obtained in Java (39).

The reaction of seedling types and that of budded combinations are represented in Figure 1. It is obvious that the reactions mentioned above are not necessarily clear-cut, since there are gradients of the two characteristics involved, among plants of different species or varieties.

#### *Rootstocks Recommended for Tristeza-Infested Areas*

The use of an appropriate tristeza-tolerant rootstock is the only practical method of controlling the disease in infested areas.

In Brazil, the following rootstocks are at present recommended: the Caipira and related types of sweet oranges, Rangpur lime, tangerina cravo and Cleopatra mandarin, the Florida or Brazilian Rough lemon, and the trifoliata orange and some of its hybrids.

The sweet orange variety called Caipira (the name generally applied to many old seedling types of unnamed sweet orange varieties) is widely recommended for most commercial scions. It is a high yielder, but rather late to start bearing. Caipira is rather susceptible to foot-rot (*Phytophthora* spp.) and is sensitive to drought. It has been shown, however, that sweet orange varieties vary in susceptibility to foot-rot, some being somewhat resistant (34). The fruit produced on trees budded on Caipira rootstock is of good quality.

The high tolerance of the Caipira sweet orange to tristeza has been shown in Brazil by the following facts: 1) trees on this rootstock survived well the disease attack in old orchards; 2) rootstock tests have ascertained its tolerance; and 3) the numerous new groves (over 500,000 trees) using this rootstock in São Paulo during the last 10 or 15 years are thriving in infested areas. It is thus rather surprising that in California the sweet oranges were not considered tolerant to quick decline (5).

The Rangpur lime has been a successful rootstock in Brazil, both before and after the advent of tristeza, and the bulk of the new plantings in São Paulo has been made on this rootstock. Most scions on Rangpur lime rootstock bear heavily and produce early crops. The trees do not grow so large as those on Caipira rootstock, and the yields per tree are slightly smaller, but could, perhaps, be compensated by a closer planting. There was a certain restriction in the past against the use of the Rangpur lime as a rootstock for certain types of scions, because the budded trees showed bark lesions and decline. After it was discovered that this type of decline was associated with the presence in the scion of a virus apparently similar to that of exocortis (28), it has become possible to recommend the Rangpur lime rootstock more widely, provided that exocortis-free budwood is available. The Rangpur lime was considered somewhat resistant to gummosis caused by *Phytophthora* (34).

Tangerine and mandarin types are generally very tolerant to tristeza (20). In both Argentina (6) and Brazil, the Cleopatra mandarin proved tolerant. Although the performance of this type of citrus as a rootstock is not yet well known in Brazil, it has been recommended to a small extent, based on information from other countries. The Cleopatra mandarin, as well as many other mandarins and tangerines, make excellent growth in the nursery.

The Florida Rough lemon and a type that has been called Brazilian Rough lemon are tristeza-tolerant rootstocks. Both types have been used to a very small extent in areas where tristeza is present.

The trifoliata orange has been found to be tolerant to tristeza in Brazil, Argentina, and Uruguay. In Brazil it has never been employed as a rootstock in commercial plantings, because trees on this rootstock are generally of small size, and intolerant to exocortis, but it seems to be used to some extent in Argentina (1) and Uruguay. With exocortis-free scions there is a possibility that the trifoliata orange may be used to advantage in areas of poorly drained soils where other rootstocks usually do not do well. Plantings on this rootstock should be set at a closer spacing than those for other usual combinations.

### New Promising Tolerant Rootstocks

Extensive co-operative rootstock tests have been carried out at Campinas and Limeira by the U. S. Department of Agriculture and the Instituto Agronômico de Campinas since 1946 (18). Over 300 different types of rootstocks were budded with three varieties of sweet oranges, two of grapefruit, and one each of tangerine, West Indian lime, and lemon. All nursery trees were systematically inoculated, and three trees of each combination that behaved as tolerant in the nursery were set out in the field. Although yield records are not yet available, data based on vigor of the trees after 4 to 5 years in the field gave the following indications. As a group, trees budded on mandarins and tangerines, or on some of the tolerant tangelos (tangelos may be tolerant or intolerant) have been slightly more vigorous than those on the sweet oranges. Two

types of Rough lemon also produced vigorous combinations. The trifoliata orange did not produce vigorous combinations, but some of its hybrids did.

Within the sweet oranges, the Florida Sweet Seedling, Parson Brown, Hamlin, and Pineapple used as rootstocks gave the most vigorous scions. They were better than Caipira, although this rootstock is rather slow at start. The following mandarins or mandarin hybrids have been outstanding as rootstocks: Oneco, Clementine, Sunki, Swatow P. I. 14054, and Swatow P. I. 10032; Sunshine, Suwanee, Minneola, Orlando, and Seminole tangelos; Rangpur lime. Among the trifoliata orange and hybrids, the best top growth was obtained on citrumelo P. I. 4475, and on Morton and Rusk citranges. The Troyer citrange seems to be a good tristeza-tolerant rootstock in California (5). Both the Florida and Brazilian Rough lemons induced excellent growth of the tops.

### **Tristeza Problems in Relation to Grapefruit and West Indian Limes**

The use of tristeza-tolerant rootstocks has been a satisfactory control measure for commercial scion varieties that have tolerant tissues; such as sweet oranges and mandarins. With those citrus scions that have intolerant tissues and permit virus increase, such as grapefruits and West Indian limes, the mere use of a tolerant rootstock does not necessarily insure freedom from injury caused by the disease. This fact is readily understood since the virus is able to increase in the scions, thereby injuring their own intolerant tissues (9). Thus, depending on the strain of tristeza virus involved, and on the relative intolerance of the host tissues, injury in these types of citrus might be of a considerable degree even on tolerant rootstocks.

Injury resulting from tristeza infection has been recorded in commercial plantings of a West Indian lime type called "limão galego" in São Paulo, although these trees were budded on tristeza-tolerant rootstocks. In a rootstock experiment at Limeira, trees of Beledy lime, budded on a number of tolerant rootstocks, showed considerable injury from tristeza and could not be considered as commercially profitable. Similar observa-

tions were made in the same experiment with Duncan and Leonardi grapefruit scions on tolerant rootstocks. A great number of trees of these two scion types were in a rather poor condition and would have to be eliminated in a commercial planting. Plants of three varieties of sweet oranges and of Dancy tangerine, on the other hand, made satisfactory growth on the same tolerant rootstocks, in spite of being infected with the same virus sources. It must be noted, however, that a very severe strain of tristeza virus had been used to inoculate the nursery plants of this experiment, so that it was not typical of most natural conditions.

The success of many groves of limão galego in São Paulo, in spite of what has been said above, is to be attributed to the selection of budwood from vigorous growing parent trees that were invaded by a mild strain of the virus, and had relatively tolerant tissues, or did not permit virus increase to attain critical levels.

In one experiment being carried out at Campinas, in which various strains of the virus were inoculated on a number of scion-rootstock combinations, trees of limão galego and Key lime inoculated with mild strains of the virus were more vigorous than comparable trees inoculated with a severe strain (11). The differences in vigor have increased lately.

Whether protection conferred by mild strains of the tristeza virus against invasion of the plant by more severe strains is of a permanent nature is still to be determined. It seems that, at least in some cases, protection is broken down. It is not unlikely, however, that a satisfactory control of tristeza for West Indian limes, grapefruit, and similarly reacting types will have to depend on the use of a tolerant rootstock budded with scions that have been previously infected artificially or naturally with mild strains of the virus.

### **Tristeza Virus Strains**

It is obvious that a virus with such a world-wide distribution as that of the tristeza disease must occur in nature as a complex of strains. Results from studies on the stem-pitting disease in South Africa (31) and on the lime disease in the Gold Coast (21) suggested the existence of virus strains



Figure 2. Reaction of five plants of Barão sweet orange budded on Watt tangelo rootstock on the same day. All buds carried the tristeza virus, but bud No. 2 was carrying a mild strain.

responsible for these two diseases, which are now considered identical with the tristeza virus.

Experimental evidence on the occurrence of mild and severe strains of the tristeza virus was first presented from Brazil (19). In New South Wales, a supposed new disease, "seedling yellows," was considered to be different from the tristeza disease (15). As pointed out previously (12), the symptoms reported to be caused by the seedling yellows virus on certain host plants were not different from those caused by inoculation of the tristeza virus on the same host plants in Brazil. It was also suggested that until more definite evidence to the contrary was obtained, seedling yellows should be considered as belonging to the tristeza virus complex. The same suggestion was also made from South Africa (24), with a theory that the tristeza virus complex has two components, the stem-pitting and the seedling yellows, and interpreting the results from

New South Wales as indicating that grapefruit plants when inoculated by the vector will filter out the seedling yellows component.

Although the idea of a stem-pitting component as part of the tristeza complex is acceptable and has been considered before, experiments carried out so far in attempts to separate the two components have given negative results.<sup>3</sup> Evidence has also been obtained indicating that the tristeza virus recovered from field-infected grapefruit trees induces both pitting and yellowing, or decline symptoms, on appropriate test plants.

The results obtained in New South Wales, namely that Eureka lemon seedlings inoculated by aphids failed to develop seedling yellows, whereas inoculation by budding caused the disease, cannot be interpreted only as lack of transmission of one of the components by the vector. It seems easier to accept these results as indicating that the inoculation

<sup>3</sup> Costa, A. S. and T. J. Grant. Unpublished work.



Figure 3. Reaction of Barão sweet orange budded on sour orange rootstock. Plants in row No. 1 were budded with an upper bud carrying the severe strain of tristeza virus and a lower bud carrying the mild strain; row No. 2 with the same two types of buds but in the reversed order; row No. 3 with buds carrying the severe strain only; and row No. 4 with buds carrying the mild strain only.

failed completely. This might well have occurred, since very few aphids per plant were used for inoculation. Similar results were obtained by the writer and collaborators (12) in comparing sour orange seedlings inoculated by means of the vector and by budding. In this case also inoculation by budding was much more efficient in breaking down the resistance of the sour orange to tristeza than inoculation by the vector. In these experiments a large number of viruliferous vectors were used, usually over 100 per plant. When infection was obtained in the aphid-inoculated plants, the symptoms did not differ from those obtained by inoculations with buds. The fact that tissue-union is a more efficient method for transmission than insect inoculation is known also for other virus diseases (37).

Field trees of sour orange are much more resistant to tristeza infection than seedlings in the greenhouse. Out of 66 plants of sour orange in nursery rows that were inoculated three times with large populations of the aphid vector, only 10 or 15 percent became infected. Sweet oranges became 100 percent infected under comparable conditions (9). Results with Eureka or similar lemon types indicate that they behave like the sour orange.

Observations made following the inoculation of several stock-scion combinations with several mild strains of the tristeza virus, in comparison with a severe strain, failed to show any segregation into strains that cause stem-pitting and strains that do not cause it. The differences between these strains have been more of a matter of degree in the severity of symptoms they caused.

## Interference between Virus Strains

Tests in which sweet orange buds carrying the tristeza virus were budded on a number of non-tolerant rootstocks showed that in a very small number of cases the growth made by one bud could be much better than that made by other comparable buds. Figure 2 shows the reaction of a series of 5 plants of the sweet orange variety Barão budded on the same non-tolerant rootstock (Watt tangelo). One of the buds made a fair growth, whereas the other four practically none. That this outstanding plant was invaded by a mild strain of the virus was demonstrated by means of insect transmission (19).

One experiment was carried out to verify whether or not mild and severe strains of the tristeza virus would interfere with one another when they were introduced simultaneously in the plant by budding. Four rows of five sour orange seedlings each were budded with the sweet orange variety Barão as follows: *a*) with buds carrying a mild strain of the virus; *b*) with buds carrying a severe strain; *c*) with two buds, the upper one carrying the mild strain and the lower one carrying the severe strain; *d*) with the same two kinds of buds, but in the reversed order. The results of this test (Figure 3), as recorded about three years after budding, were as follows: The scions from the buds carrying the mild strain formed the usual fair type of top; the buds carrying the severe strain made very little growth; and the other two rows budded with two buds made about the same amount of growth, which represented a blending of the individual effect of the mild and the severe strains but not exclusion of one or the other virus according to position of the bud, as described for peach yellows and little peach (22).

## Planning Rootstock Tests in Tristeza-Infested Areas

It is well known today that many standard scion varieties of citrus may carry one or more of several viruses, such as those of psoriasis, xyloporosis, exocortis, cachexia, tristeza, etc. It is thus becoming increasingly necessary that in studying the reaction of rootstock-scion combinations due attention be given to the virus problem, since their presence may mask the normal behavior of the budded combination.

For areas where tristeza has become prevalent, rootstock-scion combinations should be studied in presence of the virus. Thus, in planning rootstock tests it becomes important to have, on each rootstock, scions that originated from buds infected by mild and severe strains of tristeza virus, as well as scions that are to become naturally infected by the locally occurring strains.

It is not known yet whether xyloporosis, cachexia and exocortis are transmitted in nature by other means than perpetuation through the buds. If vectors of these diseases are non-existent or of little efficiency, it might be relatively easy to eradicate them through the use of certified budding stocks. In interpreting the results from rootstock tests now being carried out at different places, it must be considered that in many instances the tristeza virus might be coexisting with other viruses in the budded combinations. The interference of other viruses with the tristeza virus is an important problem for areas where this disease occurs. This problem is being studied in Florida<sup>4</sup> and in Brazil.

<sup>4</sup> Communication from Dr. T. J. Grant, Pathologist, Subtropical Fruit Investigations, U. S. Department of Agriculture, Orlando, Florida.

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# The Threat of Tristeza Disease in the Mediterranean Basin

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After the tristeza disease has spread from South Africa to South America and the United States, only the Mediterranean basin appears to be free from this disease. This is also the only area among the important centers of citriculture, where sour orange is still used almost exclusively as a rootstock, even in new plantations.

Since other contributions to this symposium have dealt with various aspects of the tristeza disease, the present article will be limited to the discussion of the occurrence of the disease in the Mediterranean area, the danger of its spread, and the means for its prevention. The author has recently had the opportunity of visiting the main centers of citriculture in the United States and Brazil, on a study trip sponsored jointly by the United States Operations Mission and FAO. The following conclusions and recommendations are, therefore, based on observations made and information received during this trip, as well as on observations in the author's own country.

## Occurrence

Until a year ago, nothing was known about the occurrence of tristeza in the Mediterranean area, and its presence was generally denied. But the reports of Olson and Sleeth (4) and Wallace and Drake (6) on the presence of tristeza virus in the Meyer lemon strongly suggested that this virus might be present in the area, in many of the citrus varieties introduced from tristeza-infected regions during the last twenty years. A number of those introduced varieties did not thrive on sour orange and were consequently considered to be incompatible with

this rootstock; among them are the Meyer lemon and mandarines from Australia and Japan.

Recently Reichert *et al* (5) confirmed the presence of tristeza virus\* in Israel in the Meyer lemon. Therefore, the other introductions, which cannot be grown on sour orange are also suspected of being carriers of this virus. Furthermore it might be surmised that every citrus variety, which was introduced from regions now known as tristeza-affected, is a potential carrier of this virus.

The Cecily grapefruit, which has been recognized as a tristeza carrier, was introduced into Cyprus, but the trees were uprooted two years ago on the advice of R. H. Marloth of South Africa.<sup>1</sup>

## Danger of Spread

Olson and Sleeth (4) and Wallace and Drake (6) state that the tristeza disease has never been found to spread from the Meyer lemon. In Israel also, it has not spread from this and other suspected varieties, nor has it been disseminated from the Cecily grapefruit in Cyprus. Those facts naturally lead to the question as to why there has been no spread.

The first answer seems to be that there is no effective vector in the Mediterranean area. *Aphis citricidus*, which is responsible for the wide spreading of the disease in South Africa and Brazil, is not found in this area. *Aphis gossypii* and *Toxoptera aurantii* are universally distributed throughout the Mediterranean area, but both are found to be inefficient vectors in the United States.

\* Oral communication from Mr. Y. Patt.

The former species is known to feed on citrus only in exceptional cases in the Mediterranean area.

Another answer may lie in the virus strain involved. In discussing this matter with the author, both T. J. Grant of Florida and A. S. Costa of Brazil, were of the opinion that the presence of a mild virus strain, together with the absence of efficient vectors, was largely responsible for the lack of spread of tristeza in the Mediterranean area. But the quick decline of the above mentioned varieties when budded on sour orange seems to indicate that a virulent strain is involved. Meyer lemon in particular always failed completely from the beginning on this rootstock.

If tristeza has been present in the Mediterranean area for the last fifteen years at least, and has shown no spread whatsoever, can this fact be considered to indicate that tristeza will not become in the future a menace in the area? In the author's view, a potential danger does exist in the following possibilities:

a) There is a remote possibility that a strain of local *aphis* might become an efficient vector of the disease. Nothing similar has ever been observed elsewhere, but the contingency should be taken into account, far-fetched as it may seem.

b) The virus, until now in a non-transmissible state, might be "activated" and become transmissible. It might be possible for transmission from one host to another to induce changes in the molecular structure of the virus, making it readily transmissible by the known or new vectors. The transfer to other tolerant rootstocks of tristeza-carrying varieties could bring about those changes. However, some Australian mandarin varieties and the Meyer lemon have been budded onto Rough lemon stock in Israel; in all cases the trees developed satisfactorily and, in spite of carrying the virus, no spread from them has yet occurred.

c) The greatest danger appears to be the re-budding of local standard varieties on virus carriers budded to tolerant rootstocks. As the rootstock is tristeza tolerant, the re-bud will develop almost normally. But the standard variety, in this instance, will become a virus carrier itself, and, when budwood from those trees is budded to sour orange, tristeza will show its effects.

### Prevention of Spread

In order to prevent the spread of tristeza in the Mediterranean basin, effective measures must be adopted by all countries in the area.

First of all, every variety introduced during the last 20 years must be checked for the presence of tristeza virus. As Reichert (5) has shown, Egyptian lime is as good an indicator plant as the Key or West Indian lime. If there is a positive reaction, every single tree of this introduction or of its progeny must be destroyed. If the variety is valuable, immediate efforts should be made to grow nucellar strains of it.

In Israel, as soon as Meyer lemon was recognized to be a tristeza carrier, legislation was immediately promulgated to enforce the uprooting and destruction of all Meyer lemon trees. There are about 250 Meyer lemon trees in Israel and almost every one can be located.

To avoid the possible danger arising from the development of a new and effective vector, extensive rootstock experiments should be set up in every Mediterranean country to find a substitute for the tristeza-susceptible citrus rootstocks, especially the sour orange. The new rootstocks should be resistant, or at least tolerant, also to other citrus viruses to avoid further complications, such as occurred with the exocortis virus on Rangpur lime in Brazil (3).

Simultaneously the old standard varieties should be rejuvenated by the development of nucellar strains, by which not only tristeza but especially psorosis and exocortis can be effectively controlled.

Bennet and Costa (1) have shown that tristeza is not transmitted by seed. It is possible, therefore, to introduce seeds of valuable citrus varieties and rootstocks without the danger of introducing the virus. On the other hand, the import of citrus plants, or parts of plants, must be prohibited or rigorously restricted by efficient quarantine measures. In this respect the plant quarantine regulations of the United States may be taken as an example. They provide that in no case may original budwood be distributed; even after the original introduction has been checked and found free of tristeza, only budwood from the second or third progeny may be distributed.

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# The Tropical Citrus Aphid

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THE "tropical citrus aphid," *Toxoptera citricidus* (Kirkaldy), has often been confused with *T. aurantii* (B. d. F.), many records of the latter applying to *citricidus* (but only rarely the other way about). Essig (2) has figured both species, listed host plants and localities and given a bibliography. The two species differ as follows:

## *Apterae viviparae*

*T. citricidus*. Siphunculi heavily imbricated and  $1\frac{1}{10}$  —  $1\frac{1}{2}$  as long as the cauda which bears 25 to 35 hairs. Longest hairs on third antennal segment  $1\frac{1}{4}$  —  $1\frac{1}{2}$  times as long as the basal diameter of the segment. Longest hairs on hind tibiae  $1\frac{1}{2}$  —  $2\frac{1}{4}$  times distal diameter of tibiae. Processus terminalis  $1\frac{1}{10}$  —  $1\frac{1}{4}$  times as long as third antennal segment. Usually on Rutaceae, only rarely on other shrubs.

*T. aurantii*. Siphunculi normally imbricated and  $\frac{9}{10}$  —  $1\frac{1}{4}$  as long as the cauda which bears only 9 to 17 hairs. Longest hairs on third antennal segment shorter than the basal diameter of the segment. Longest hairs on hind tibiae  $1\frac{1}{4}$  —  $1\frac{1}{2}$  times distal diameter of tibiae. Processus terminalis  $1\frac{1}{4}$  —  $1\frac{1}{2}$   $\times$  third antennal segment. On many shrubs, common on Rutaceae.

## *Alatae viviparae*

*T. citricidus*. Media of fore-wing normally twice-branched. Siphunculi  $1\frac{1}{4}$  —  $1\frac{3}{4}$  times as long as the cauda which bears 22 to 32 hairs. Longest hairs on third antennal segment longer than the basal diameter of the segment. Third antennal segment black, except for a small pale basal area, and bearing 8 to 20 rhinaria; fourth antennal segment bearing 0 to 4 (often 0).

*T. aurantii*. Media of fore-wing often only once-branched (see below). Siphunculi from equal to, to  $1\frac{2}{5}$  as long as the cauda, which bears only 8 to 13 hairs. Longest hairs on third antennal segment shorter than the basal diameter of the segment. Third antennal segment pale, except for the very apex which is dark, and bearing 3 to 8 rhinaria; fourth antennal segment without rhinaria.

N. B. Larvae of both species have long tibial hairs. In Africa, alatae of *T. aurantii* normally have the media of the fore-wing only once-branched, but specimens from the Far East with twice-branched media are quite common.

A useful field character is that disturbed colonies of *Toxoptera aurantii* produce a distinct scraping sound, audible with a large colony as much as 18 inches from the leaf, whereas those of *T. citricidus* do not.

There is material of *Toxoptera citricidus* in the collections of the British Museum from Belgian Congo, Gold Coast, Kenya, Nyasaland, South Africa, Southern Rhodesia, Sudan, Tanganyika, Uganda, Mauritius, India, Thailand, Malaya, Australia, Fiji, Hawaii, New Zealand and Samoa (Upola Island). In addition, there are records in the literature from other parts of Africa (south of the Sahara), Japan, Formosa, China, Ceylon, Java, Sumatra, Argentina, Brazil, Chile, Peru and Trinidad (British West Indies). There are also records from Cyprus, Italy, Malta, Sicily and Spain, but no material has been seen from the Mediterranean region and since the aphids of Egypt and Israel are quite well known it seems likely that the Mediterranean records apply to *aurantii*.

Synonyms of *Toxoptera citricidus* are *Myzus citricidus* Kirkaldy, *Aphis citricidus* (Kirkaldy), *Aphis tavaresi* del Guercio and

*Paratoxoptera argentinensis* Blanchard. Takahashi (5), Hille Ris Lambers (4) and Eastop (1) concluded independently that *citricidus*

should be placed in *Toxoptera* rather than in *Aphis*. Geyer (3) has given a recent review of the synonymy.

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#### Symposium on Tristeza Disease of Citrus

This symposium, which reviews the present situation of the dangerous tristeza disease in various citrus-growing regions of the world, includes two additional papers which were published in the last issue of the FAO Plant Protection Bulletin:

Tristeza disease of citrus, with special reference to its situation in the United States, by J. M. Wallace

Tristeza and stem-pitting diseases of citrus in South Africa, by A. P. D. McClean

## Plant Quarantine Announcements

### Egypt

Order of 3 February 1955, specifying injurious diseases on imported plants and agricultural products, contains lists of plant pests and diseases which are not known to exist in Egypt and prescribes measures for preventing their introduction.

The importation of plants and plant products infected or infested by any pest or disease given in List I and List IV is prohibited.

Consignments of the following plants and plant products, when found to be infected or infested by any specific pest or disease (List II), may be permitted to be imported, after they have been treated in the prescribed manner:

- (1) Timber when infested by borers or bark beetles should be treated either in hot water at the temperature of 80°C. for 3-6 hours according to size, or by hot air at the same temperature for 10 hours.
- (2) Cocoa beans and nutmeg when infested by *Araecerus fasciculatus* (coffee bean weevil) should be roasted at a temperature not lower than 100°C. for at least 15 minutes.
- (3) Flower bulbs when infested by *Rhopalosiphoninus* spp. (aphids) should be treated by dipping in a solution of nicotine sulphate (0.15 percent) and soap for two minutes and then be exposed to air for 48 hours.
- (4) Flower bulbs when infected by *Fusarium bulbigenum* (narcissus basal rot), *Stagonospora curtissi* (narcissus leaf scorch), *Ramularia vallisumbrosae* (white mould of narcissus), or *Rhizoctonia tuliparum* (grey bulb rot of tulip), should be treated by dipping in a solution of mercuric chloride (0.3 percent) for 10 minutes.

The importation of plants and plant products when infested or infected by any pest or disease enumerated in List III, may be authorized only if they can be disinfested or disinfected under the supervision of the Ministry of Agriculture before leaving the customs office.

In spite of the foregoing, the importation of consignments of the following plants and plant products, even when affected by any given pest or disease (List V), may be authorized without treatment:

- a. Seed and flour contaminated by insects known to exist in Egypt.
- b. Tobacco contaminated by insects known to exist in Egypt.

- c. Apple, pear, sour orange, peach, apricot and almond affected by crown gall (*Bacterium tumefaciens*).
- d. Potatoes infected by *Actinomyces scabies* (common scab), *Spongospora subterranea* (powdery scab), or *Bacterium phytophthora* (*Erwinia atroseptica*, *Bacillus atrosepticus*, blackleg), if the infection does not exceed 10 percent.
- e. Potatoes infected by *Phytophthora infestans* (late blight), *Erwinia carotovora* (soft rot), or *Fusarium* spp. (tuber rot), if the infection does not exceed 5 percent.
- f. Apple infected by *Venturia inaequalis* (scab).
- g. Pear infected by *Venturia pirina* (scab).
- h. Peach infected by *Cladosporium carpophilum* (peach scab), or *Sphaerotheca pannosa* var. *persicae* (mildew).
- i. Peach, apricot and almond infected by *Clasterosporium carpophilum* (shot hole) or *Bacterium (Xanthomonas) pruni* (black spot).
- j. Apricot infected by *Podosphaera oxyacanthae* (mildew).

Plant materials infested or infected by a pest or disease which cannot be specifically identified are prohibited to be imported, unless they can be effectively treated within the customs area. This provision is also applicable to other pests and diseases which are not given in the lists annexed to the Order but are established to be non-existent in Egypt.

Lists I, III and IV are obtainable from the Crop Protection Department, Ministry of Agriculture, Cairo, and can also be furnished by the Plant Production Branch, Agriculture Division, FAO.

The Crop Protection Department of the Ministry of Agriculture of Egypt published in 1956 a "List of prohibited pests and diseases likely to be found on plants and plant products imported from abroad" which may be referred to in connection with the Order abstracted here.

### United Kingdom (England and Wales)

The Importation of Potatoes Order of 22 February 1956 modifies, for the period from 24 February to 31 May 1956, the restrictions imposed by the Importation of Plants Order, 1955 (see *FAO Plant Prot. Bull.* 3: 60-62, 1955), on the importation into England and Wales of potatoes grown in 1955 in Belgium, France or the Nether-

lands. Such potatoes may be imported, provided that:

- a. They have been grown in a district where an intensive system of control of Colorado beetle (*Leptinotarsa decemlineata*) is in operation;
- b. they have been riddled in a packing station which has been inspected and approved,

- by the phytopathological service of the country of origin, the said riddling being subject to inspection by an authorized officer, and are free from soil and Colorado beetle infestation; and
- c. immediately after riddling they have been securely packed in new bags with the label of the packing station attached to each bag.

## News and Notes

### Desert Locust Control

FAO convened two meetings on desert locust control in Addis Ababa, Ethiopia, in February and March 1956. The first, attended by representatives of the Governments of Ethiopia, France, Italy, Sudan, the United Kingdom and the United States of America, was planned to discuss how co-operative action against the desert locust in Ethiopia and the surrounding territories, especially the Somalilands, might be intensified and placed on a more permanent basis. The following were the main conclusions and recommendations:

1. The Ethiopian-Somali area is one of the most frequently infested sections of the whole desert locust invasion area. Apart from their local importance, the infestations there constitute a threat to other territories and swarms produced within the area can have an important effect on the over-all developments of desert locust plagues. It was considered that no general control of desert locust plagues could be expected until destruction of swarm breeding in the Ethiopian-Somali area could be assured.

2. Despite recent heavy locust infestation, the whole of the area and British East Africa was free from any important desert locust concentrations in February 1956, though there was a danger that the area might be reinfested during 1956.

3. The steps taken by the Ethiopian Government to establish a strong national anti-locust organization were highly commended by the meeting. This organization, with interna-

tional assistance, was able to accept responsibility for locust control throughout Ethiopia.

4. The Co-ordinating Committee, on which was represented Ethiopia, the British Desert Locust Control organization, the U. S. A. International Co-operation Administration and FAO, and which was established by the Ethiopian Government in 1953, had proved an outstanding example of international co-operation within Ethiopia. The meeting recommended, however, that an international consultative committee should be established by FAO in order to make the most effective use of national and international resources throughout the Ethiopian-Somali area.

At the second meeting discussions were held between representatives of the Governments of France and the Sudan regarding joint action against the desert locust along the frontier areas of Chad Territory and the Sudan. It appeared that locust swarms coming from the east and the west may converge in this area before dispersing to breed over extensive areas of the African summer rainfall belt. Consideration was given as to the manner by which more reliable information on swarm movements and meteorological data could be obtained and how swarms in this area might be destroyed. Particular attention was given to the possibility of operating aircraft for reconnaissance and control. Recommendations were also made for establishing closer co-operation between the governments of Chad Territory and the Sudan on all aspects of desert locust control.

## PLANT BREEDING ABSTRACTS

*Plant Breeding Abstracts* is a quarterly journal containing abstracts of current literature throughout the world. All publications having a direct or indirect bearing on the breeding of economic plants are mentioned, the fields covered including genetics, cytology, evolution, practical improvement by selection and by more modern methods such as induced mutation and polyploidy, the use of hybrid vigor in raising yields, and the application of interspecific crosses to utilize the valuable genes of wild and indigenous floras. Not only the commoner crop plants are considered but also vegetables, temperate and tropical industrial plants and fruits, and even forest trees. A large section is also devoted to the genetics of microorganisms such as fungi, bacteria and virus, which are of interest both theoretically, as material for study of the basic principles of heredity, and practically, for producing improved strains for brewing and other industrial purposes, and also for building-up disease-resisting forms of agricultural plants.

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